DTC P0AC0 - Current Sensor Fault

Product Family	Fault Supported
Orion BMS [Original] (24 - 180 Cell)	**YES**
Orion BMS 2 (24 - 180 Cell)	**YES**
Orion JR [Original] (16 Cell)	**YES**
Orion JR 2 (16 Cell)	**YES**

FAULT DESCRIPTION

The Orion BMS uses an external current sensor to measure and track the amount of current (amperage) going into and out of the battery pack. This allows the BMS to accurately track State of Charge, Cell Resistances (impedance), calculate current limits and observe the overall pack health.

There are two different types of current sensors used by our products: Hall Effect and Shunt Sensors:

- Hall effect sensors work by measuring the magnetic field generated by current as it travels through the power cables and are fully passive (they go around the power cables and thus are non-invasive). This value is converted by the sensor to a linear 0-5v analog signal that is measured by the BMS.
- Shunt sensors are technically large resistors that intentionally cause a predictable voltage drop across them when current is run through, allowing the BMS to determine the overall amount of current flowing through based on how much voltage drop is present across the sensor. Because this voltage drop is extremely small (+/- 50mV for the full range of the sensor) it can be very difficult to observe this without high precision equipment.

Because this sensor is very important to the overall product operation, the BMS will monitor the behavior of it continuously. There are a number of abnormal conditions that will trigger this fault.

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Fault Code	Fault Description	Possible Trouble Area
P0AC0: Subcode 0 Subcode 1	The BMS has determined that the current sensor is either unplugged (disconnected), that the wiring harness for it is damaged (cut, crushed or otherwise), or that the current being run through the sensor is exceeding the maximum ratings for the sensor (maxing out the sensor by over saturation).	• Current Sensor • Current Sensor Wire Assembly • Application Drawing Too Much Current
P0AC0: Subcode 2	An abnormal relationship between the two channels inside the current sensor was detected. Current sensor channel wires may be switched OR the wrong current sensor may be selected. **(Hall Effect Sensors Only)**	• Current Sensor • Current Sensor Wire Assembly • Configuration Settings (Selected Current Sensor)
P0AC0: Subcode 3	The polarity (directionality) of the current sensor appears to be reversed or installed backwards.	• Configuration Settings (Current Sensor Polarity)
P0AC0: Subcode 4	An abnormal relationship between the two channels inside the current sensor was detected. Current sensor channel wires may be switched OR the wrong current sensor may be selected. **(Hall Effect Sensors Only)**	• Current Sensor • Current Sensor Wire Assembly • Configuration Settings (Selected Current Sensor)
P0AC0: Subcode 5	Current Sensor 5v Power Source Fault. Current Sensor wires may be shorted. **(Hall Effect Sensors Only)**	• Current Sensor • Current Sensor Wire Assembly • Internal BMS Fault

The following diagram describes the voltage relationship between the Hall Effect current sensor output signal and the actual measured current. Note that the Hall Effect current sensor has 2 separate output channels (one for high current and one for low current).

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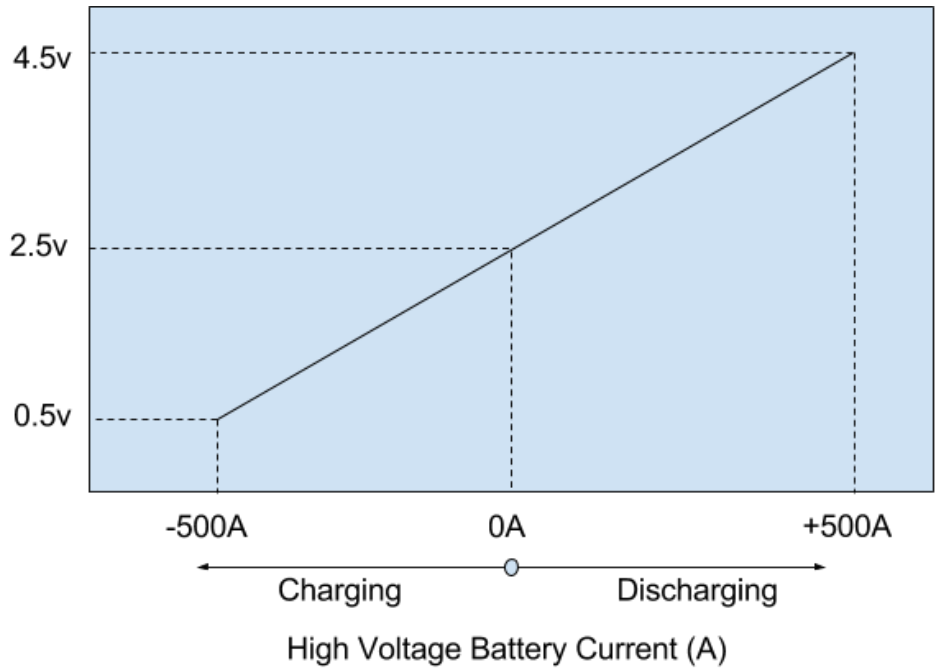

Above diagram demonstrates relationship between current sensor output voltage and current measured for **hall effect** style sensors

FAULT BEHAVIOR

This fault will trigger **Current Sensor Failsafe Mode** which will inhibit the BMS from using the values from the current sensor in calculations.

This impacts the following calculations:

- State of Charge (coulomb counting is disabled)
- Cell Internal Resistances (resistance calculation is disabled)
- Current Limits (limit determination accuracy is severely reduced, limit enforcement is not available)
- Open Cell Voltages (back calculation of open or sitting cell voltages under load)

FAULT THRESHOLDS

Fault will trigger when **ANY** of the following conditions are satisfied	(a) **OR** (b) **OR** (c) **OR** (d)
(a) Current sensor maximum range exceeded	Measured value from current sensor exceeds the maximum range ratings for the sensor itself (or the

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	sensor is reading as disconnected)
(b) Abnormal relationship between channel 1 and channel 2 on current sensor **(Hall Effect Sensors Only)**	Measured values from the dual channels inside the current sensor present conflicting data
(c) Current appears to be measured backwards	The current sensed appears to be backwards or inverted (eg: discharging the pack results in higher pack voltage)
(d) Currents sensor power supply failure **(Hall Effect Sensors Only)**	The 5v power supply for the current sensor is outside acceptable range.

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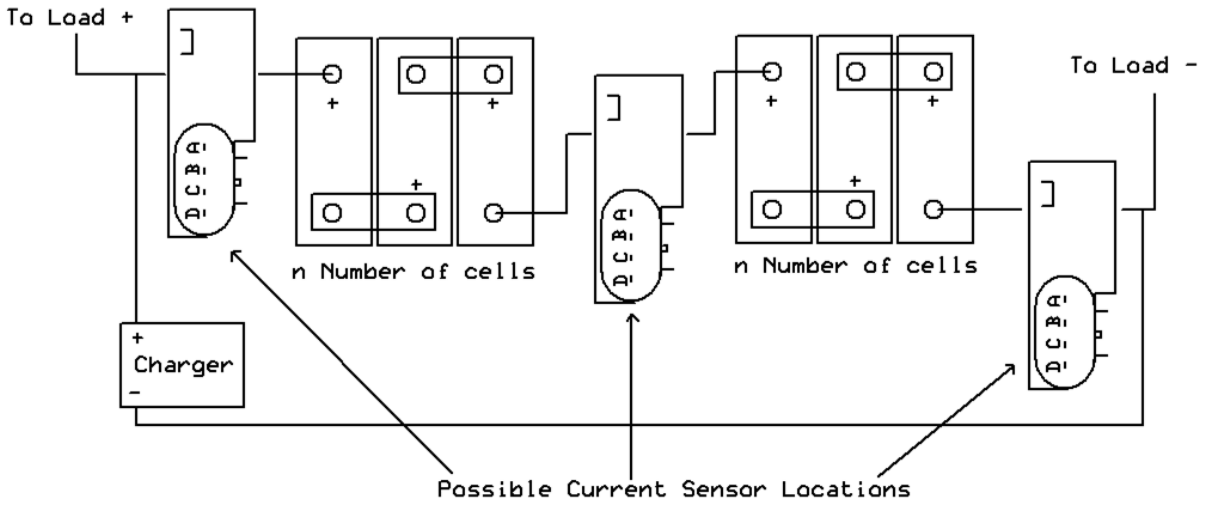
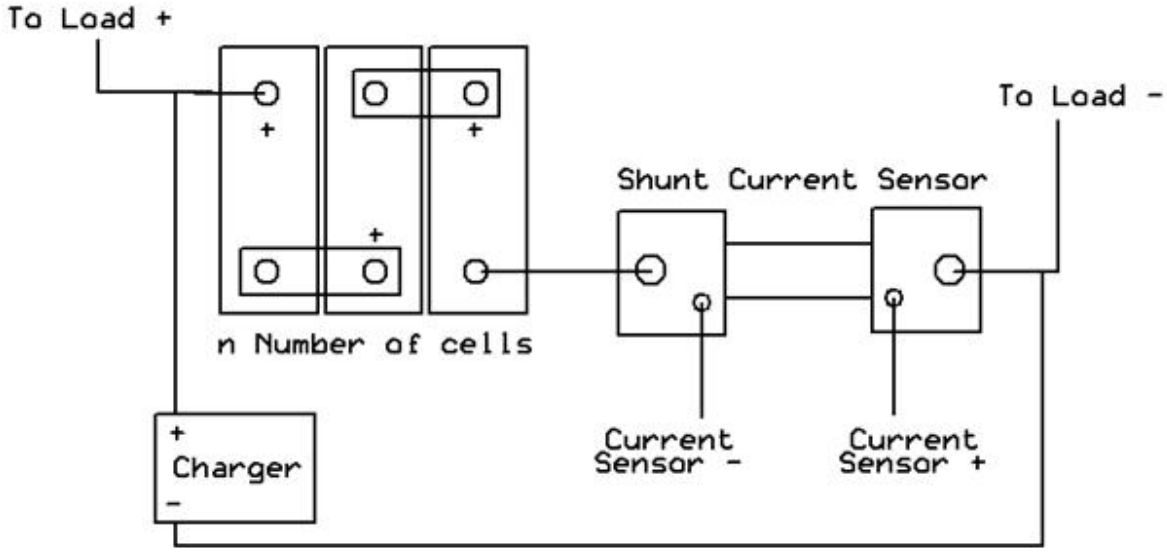
WIRING DIAGRAM

Hall Effect Style



Schematic showing possible locations of **Hall Effect** style sensor

Shunt Style



Schematic showing the current sensor wiring for a **Shunt style** sensor

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DIAGNOSTIC STEPS

1.	**Verify that the current sensor is correctly wired and plugged in.** If the current sensor is miswired or disconnected this will result in a fault being set. Carefully inspect the wiring harness going from the BMS to the current sensor to ensure that it is both wired properly and free from defect or damage (a damaged or cut wire would also result in a fault). If the current sensor is intentionally disconnected or not used (for applications opting to forego the sensor entirely), the current sensor itself must be disabled on the "General Settings" tab in the BMS utility (by selecting "None" in the "Selected Current Sensor" field). **For Hall Effect sensors, make sure that the connector on the current sensor is securely plugged in (it should click indicating it is successfully mated).** **For Shunt style sensors (this does not apply to hall effect style sensors), make sure the current sensor is installed right before the NEGATIVE side of the battery pack, just before cell 1 negative. The sensor should be installed as close to the battery pack negative terminal as possible.**
2.	**Verify that the correct current sensor is selected in the BMS settings.** **Accidentally selecting the incorrect current sensor is a very common mistake and can easily result in a fault being generated** (in addition to reduced accuracy and invalid readings). Steps to verify: 1) Visually inspect the current sensor to determine the model number of the sensor being used. For Hall Effect style current sensors (black, plastic) the model number will begin with "DHAB" (eg: DHAB S/34, DHAB S/155, etc). For Shunt style current sensors (metallic with 2 large terminals) the model number is inscribed on the metal finish (eg: 500A 50mV). 2) In the BMS utility, click on the "General Settings" tab and review the "Selected Current Sensor" item. If the two differ, correct the value in the utility and upload the new settings to the BMS.
3.	**Verify that the current sensor is correctly sized for the application.** Each current sensor, regardless of type, has a maximum current rating (expressed in amps) that determines the total amount of current that it can sense in either direction (both current going into the battery pack and current going out of the battery pack). This rating is usually included in the name or

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	description of the current sensor and is the single most important factor to consider when sizing a current sensor for an application. **If the current draw from the application ever exceeds the maximum current rating for the sensor, the BMS will set a fault code because it does not know whether the sensor itself is damaged (shorted) or whether the current draw is more than it can handle.** There is some hysteresis in the BMS to allow several brief moments of high current events without setting a fault but this should not be relied on to regularly avoid faults being set. **NOTE: The general rule to follow is to select the smallest possible current sensor with a maximum amperage rating of at least 10% larger than the maximum peak current draw the application will see.**
4.	**Attempt to replace the suspected components.** If possible, try using a known good current sensor or wiring harness assembly to rule out components.
5.	**Download the freeze frame for the fault code using the BMS Utility.** The BMS will normally produce a freeze frame on the "Diagnostic Trouble Codes" screen in the BMS Utility when this fault code occurs that contains a comprehensive list of BMS data parameters at the time the fault occurred. **It is strongly recommended that the freeze frame be downloaded from the BMS and saved to disk before the fault is cleared again** as this data may assist in the future if further diagnostics are required. Additionally this freeze frame data may be requested by Technical Support if further assistance is required. **NOTE:** Only Fault Codes with a (F) next to them have freeze frame data available for download. If there is no (F) next to the fault, there is no stored freeze frame available and this step can be skipped. Steps to download the Freeze Frame: 1) Connect to the BMS using the Orion BMS utility. 2) Click the "Diagnostic Trouble Codes" tab at the top. 3) Select the correct fault code by clicking on the ID on the left side of the screen to initiate the Freeze Frame retrieval. 4) Once the retrieval process is complete, click the "Export (CSV)" button to save the freeze frame data to the computer disk.
6.	**If the problem persists, contact technical support.** If all above steps fail to determine the cause of the fault then additional support is needed.

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	Please contact the company or reseller that the BMS was originally purchased from for additional questions, warranty claims, repair requests and technical support.

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